FORM PTO-1390 (Modified) (REV 11-98) U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371

ATTORNEY'S DOCKET NUMBER	U.S. APPLICATION NO. (IF KNOWN, SEE 37 CFR)
112740-206	09/807677

INTERNATIONAL APPLICATION NO.	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED
PCT/DE99/03166	01 October 1999	15 October 1998

TITLE OF INVENTION
MOBILE RADIO SYSTEM, AND MOBILE STATION

APPLICANT(S) FOR DO/EO/US
Ludwig Hofmann

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☒ This is an express request to begin national examination procedures (35 U.S.C. 371(f)) at any time rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and PCT Articles 22 and 39(1).
4. ☒ A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.
5. ☒ A copy of the International Application as filed (35 U.S.C. 371 (c) (2))
   a. ☒ is transmitted herewith (required only if not transmitted by the International Bureau).
   b. ☐ has been transmitted by the International Bureau.
   c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).
6. ☒ A translation of the International Application into English (35 U.S.C. 371(c)(2)).
7. ☒ A copy of the International Search Report (PCT/ISA/210)
8. ☒ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371 (c)(3))
   a. ☒ are transmitted herewith (required only if not transmitted by the International Bureau).
   b. ☐ have been transmitted by the International Bureau.
   c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
   d. ☐ have not been made and will not be made.
9. ☒ A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
10. ☒ An oath or declaration of the inventor(s) (35 U.S.C. 371 (c)(4)).
11. ☒ A copy of the International Preliminary Examination Report (PCT/IPEA/409).
12. ☐ A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371 (c)(5)).

Items 13 to 20 below concern document(s) or information included:

13. ☐ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
14. ☒ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
15. ☒ A **FIRST** preliminary amendment.
16. ☐ A **SECOND** or **SUBSEQUENT** preliminary amendment.
17. ☒ A substitute specification.
18. ☐ A change of power of attorney and/or address letter.
19. ☒ Certificate of Mailing by Express Mail
20. ☒ Other items or information:

Submission of Drawings Figures 1-6 on four sheets

U.S. APPLICATION NO. (IF KNOWN, SEE 37 CFR)	INTERNATIONAL APPLICATION NO.	ATTORNEY'S DOCKET NUMBER
09/807677	PCT/DE99/03166	112740-206

21. The following fees are submitted:.

BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)) :

		CALCULATIONS PTO USE ONLY
☐	Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2) paid to USPTO and International Search Report not prepared by the EPO or JPO	**$1,000.00**
☒	International preliminary examination fee (37 CFR 1.482) not paid to USPTO but Internation Search Report prepared by the EPO or JPO	**$860.00**
☐	International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO	**$710.00**
☐	International preliminary examination fee paid to USPTO (37 CFR 1.482) but all claims did not satisfy provisions of PCT Article 33(1)-(4)	**$690.00**
☐	International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(1)-(4)	**$100.00**

ENTER APPROPRIATE BASIC FEE AMOUNT = **$860.00**

Surcharge of **$130.00** for furnishing the oath or declaration later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492 (e)). **$0.00**

CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE	
Total claims	50 - 20 =	30	x $18.00	**$540.00**
Independent claims	2 - 3 =	0	x $80.00	**$0.00**
Multiple Dependent Claims **(check if applicable)**.			☐	**$0.00**

TOTAL OF ABOVE CALCULATIONS = **$1,400.00**

Reduction of 1/2 for filing by small entity, if applicable. Verified Small Entity Statement must also be filed (Note 37 CFR 1.9, 1.27, 1.28) **(check if applicable).** ☐ **$0.00**

SUBTOTAL = **$1,400.00**

Processing fee of **$130.00** for furnishing the English translation later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492 (f)). + **$0.00**

TOTAL NATIONAL FEE = **$1,400.00**

Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31) **(check if applicable).** ☐ **$0.00**

TOTAL FEES ENCLOSED = **$1,400.00**

Amount to be: refunded $

charged $

☒ A check in the amount of **$1,400.00** to cover the above fees is enclosed.

☐ Please charge my Deposit Account No. in the amount of to cover the above fees.
A duplicate copy of this sheet is enclosed.

☒ The Commissioner is hereby authorized to charge any fees which may be required, or credit any overpayment to Deposit Account No. **02-1818** A duplicate copy of this sheet is enclosed.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:

William E. Vaughan
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P.O. Box 1135
Chicago, IL 60690-1135

SIGNATURE

William E. Vaughan
NAME

39,056
REGISTRATION NUMBER

April 16, 2001
DATE

BOX PCT

IN THE UNITED STATES ELECTED/DESIGNATED OFFICE
OF THE UNITED STATES PATENT AND TRADEMARK OFFICE
UNDER THE PATENT COOPERATION TREATY-CHAPTER II

APPLICANT: Ludwig Hofmann DOCKET NO: 112740-206
SERIAL NO: GROUP ART UNIT:
EXAMINER:
INTERNATIONAL APPLICATION NO: PCT/DE99/03166
INTERNATIONAL FILING DATE: 01 October 1999
INVENTION: MOBILE RADIO SYSTEM, AND MOBILE STATION

Assistant Commissioner for Patents,
Washington, D.C. 20231

SUBMISSION OF DRAWINGS

Applicant herewith submits four sheets (Figs. 1-6) of drawings for the above-referenced PCT application.

Respectfully submitted,

(Reg. No. 39,056)

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Attorneys for Applicant

FIG. 1

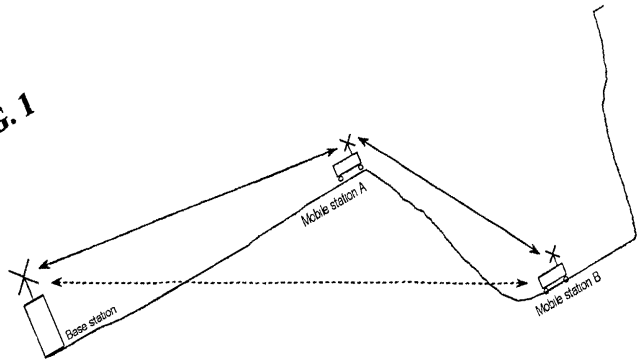


FIG. 2

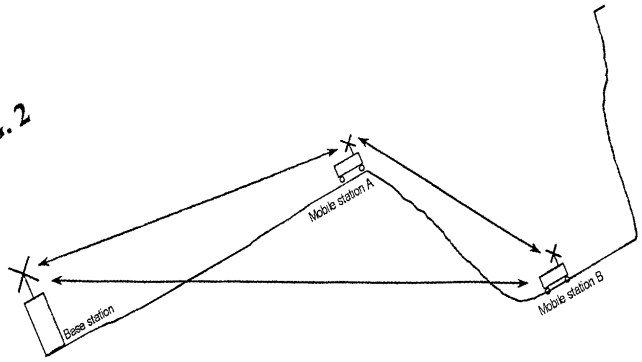


FIG. 3

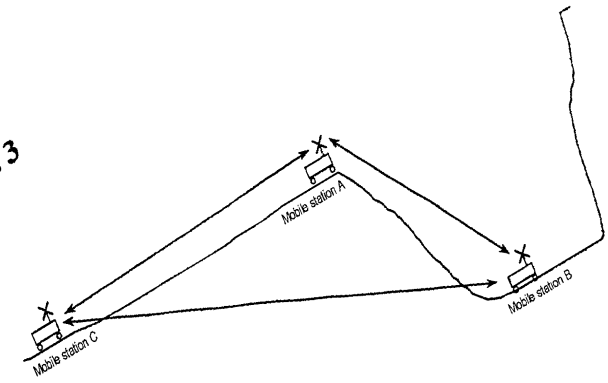


FIG. 4

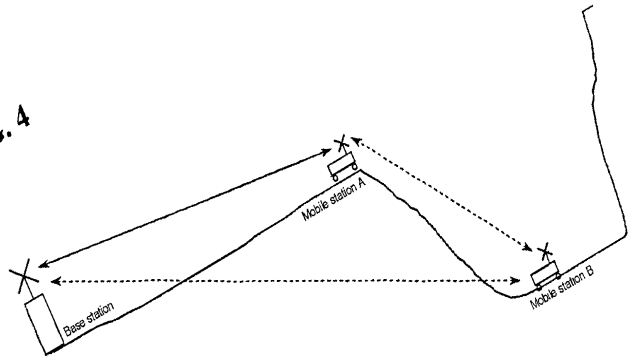


FIG. 5a

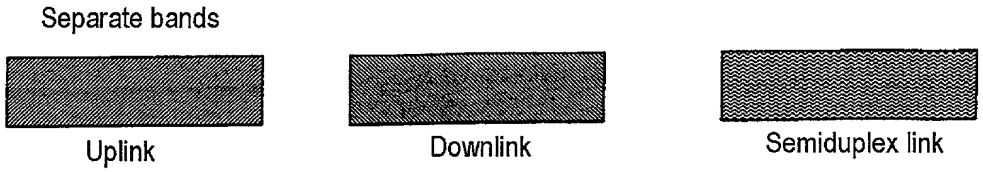


FIG. 5b

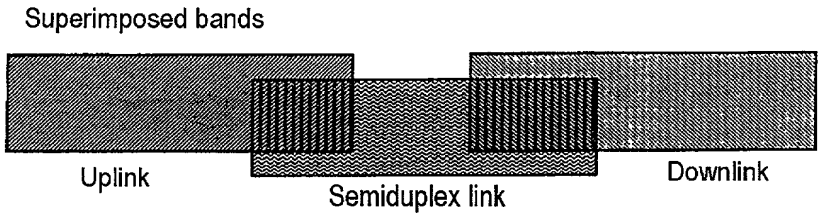


FIG. 6a

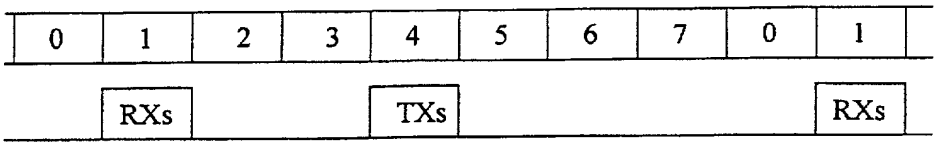


FIG. 6b

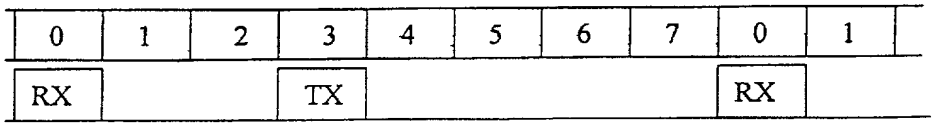
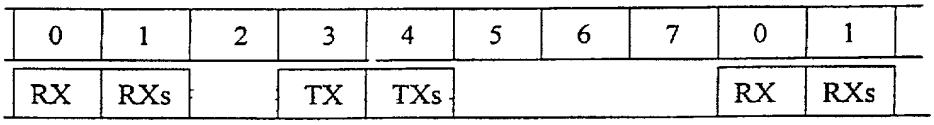


FIG. 6c



BOX PCT

IN THE UNITED STATES ELECTED/DESIGNATED OFFICE
OF THE UNITED STATES PATENT AND TRADEMARK OFFICE
UNDER THE PATENT COOPERATION TREATY-CHAPTER II

PRELIMINARY AMENDMENT

APPLICANT:	Ludwig Hofmann	DOCKET NO: 112740-206
SERIAL NO:		GROUP ART UNIT:
		EXAMINER:
INTERNATIONAL APPLICATION NO:		PCT/DE99/03166
INTERNATIONAL FILING DATE:		01 October 1999
INVENTION:	MOBILE RADIO SYSTEM, AND MOBILE STATION	

Assistant Commissioner for Patents,
Washington, D.C. 20231

Sir:

Please amend the above-identified International Application before entry into the National stage before the U.S. Patent and Trademark Office under 35 U.S.C. §371 as follows:

In the Specification:

Please replace the Specification of the present application, including the Abstract, with the following Substitute Specification:

SPECIFICATION

TITLE

MOBILE RADIO SYSTEM, AND MOBILE STATION

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to a mobile radio system and to a mobile station which are suitable for carrying out transmission/reception operation in the duplex and semiduplex mode.

Description of the Prior Art

Previous mobile radio systems operating in the duplex mode operate at specific uplink and downlink frequencies, with each mobile station needing to have a direct link to a base station. In this case, signals between two mobile stations are not transmitted directly from one

mobile station to the other, but via one or more base stations depending on the location of the mobile stations. If there is no link from the mobile stations to a base station, no link can be set up to another mobile station. Such a situation is shown in Figure 4. Although, as shown in Figure 4, the mobile station A can set up a link to the base station, the mobile station B cannot, since it is out of range of the base station (for example, in a valley or on a bridge). No link, therefore, can be set up between the mobile stations A and B even if, for example, there is a visual link between them. Since it has so far not been possible to overcome this disadvantage with mobile radio systems operating in the duplex mode, additional systems such as TETRA (Trans European Trunked Radio Access) have been developed and constructed, in which communication takes place directly between two mobile radios without using a base station. However, a mobile radio system operating in the duplex mode is advantageous for effective use of the available frequencies and base stations.

An object of the present invention is, thus, to provide a mobile radio system and a mobile station which, in addition to transmission/reception operation in the duplex mode, are also suitable for transmission/reception operation in the non-duplex mode.

SUMMARY OF THE INVENTION

Accordingly, a mobile radio system having a number of mobile stations is provided, in which the mobile stations carry out transmission/reception operation in the duplex mode and in the semiduplex mode. The mobile stations are, thus, suitable for setting up communication to one or more mobile stations using the duplex and/or semiduplex mode.

According to one embodiment of the present invention, a first mobile station carries out transmission/reception operation with a base station in the duplex mode, and with a second mobile station in the semiduplex mode. This allows simultaneous communication to be set up from the first mobile station in the duplex mode to the base station and to a second mobile station in the semiduplex mode, even when there is no link from the second mobile station to the base station.

Furthermore, transmission/reception operation can be carried out with the base station in the duplex mode and with the second mobile station in the semiduplex mode, such that the transmission/reception operation is carried out cyclically in timeslots, and the timeslots for the duplex and semiduplex mode run synchronously with respect to one another. The timeslots for the duplex and semiduplex mode, thus can be superimposed (interleaved) in

such a manner that the transmission/ reception operation is carried out virtually simultaneously in the duplex and semiduplex mode without any mutual influence.

If the first mobile station carries out transmission/ reception operation with the base station in the duplex mode and with the second mobile station in the semiduplex mode, such that signals from the base station are transmitted via the first mobile station to the second mobile station and vice versa, communication can be set up between the base station and the second mobile station with the interposition of the first mobile station as a repeater. This can be done even when there is no direct link from the second mobile station to the base station.

In accordance with another embodiment of the present invention, the first mobile station carries out transmission/reception operation with the second mobile station and with a third mobile station in the semiduplex mode. This allows simultaneous communication to be set up directly from the first mobile station to the second and third mobile station in the semiduplex mode without any link to a base station.

If the first mobile station carries out transmission/ reception operation with the second and the third mobile station in the semiduplex mode, such that signals from the second mobile station are transmitted via the one mobile station to the third mobile station and vice versa, communication can be set up between the second and third mobile station with the interposition of the one mobile station as a repeater even when there is no link between the second and third mobile station and any base station.

If a number of mobile stations are coupled to one another, then a communication chain or communication network of any desired size can be produced, in which case communication can be set up via a number of mobile stations with or without using base stations.

In order to avoid loading the power supply device of the first mobile station in an uncontrolled manner, the first mobile station manually or automatically switches on and off the transmission of signals from the second mobile station via the first mobile station to the base station or to the third mobile station, and vice versa. The function of the first mobile station as a repeater, thus, can be activated or deactivated.

Additional features and advantages of the present invention are described in, and will be apparent from, the following Detailed Description of the Preferred Embodiments and the Drawings.

DESCRIPTION OF THE DRAWINGS

Figures 1 to 3 show various embodiments and operating modes of a mobile radio system according to the present invention;

Figure 4 shows a mobile radio system according to the prior art;

Figure 5 shows an illustration of frequency bands used in connection with the present invention; and

Figure 6 shows an illustration of timeslots used in connection with the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Conventional mobile radio systems, such as the GSM system, operate in the duplex mode and generally use a timeslot method in which the transmitter and receiver are active at different times. The transmitter in this case operates in the uplink frequency band, while the receiver operates in the downlink frequency band.

In the present invention, a semiduplex band is required as an additional band. As shown in Figure 5a, such a band may lie in another frequency band or, as shown in Figure 5b, may be arranged such that it is superimposed on the uplink and downlink frequencies.

Figure 6 shows a transmission/reception process within a transmission/reception cycle which is subdivided into eight timeslots (0 to 7). The semiduplex band (see Figure 6a) allows transmission and reception at the same frequency, with transmission and reception each being carried out in different timeslots. The reference symbol RXs in this case denotes reception, and TXs transmission of signals in the semiduplex band. The semiduplex band timeslots are synchronized to the duplex band timeslots (see Figure 6b) as in the GSM system, but they may differ both in the nature of the transmission and in length. The reference symbol RX denotes reception and TX denotes transmission of signals in the duplex band. Overall, this makes it is possible to work virtually simultaneously in both bands (see Figure 6c).

As shown in Figure 1, a mobile station A communicates with the base station using the duplex mode. In addition, the mobile station A can set up communication using the semiduplex mode with the mobile station B. There is no link between the mobile station B and the base station. It is, thus, possible for the mobile station A to communicate simultaneously with the base station and the mobile station B.

Figure 2 shows a situation in which the mobile station A is being used as a repeater. As in the situation shown in Figure 1, there is a direct link between the base station and the mobile station A, while there is no direct link between the base station and the mobile station B. However, the mobile station A converts the semiduplex mode information transmission to duplex mode information transmission, and vice versa, so that communication is set up between the base station and the mobile station B. As such, data is transmitted using the semiduplex mode from the mobile station B to the mobile station A, processed in the mobile station A and passed on using the duplex mode to the base station. In the opposite direction, the data is transmitted from the base station to the mobile station A using the duplex mode, processed in the mobile station A, and passed on to the mobile station B using the semiduplex mode.

As shown in Figure 3, it is likewise possible forthe mobile station A to communicate simultaneously with the mobile station B and the mobile station C using the semiduplex mode or, as a repeater, to receive information in the semiduplex mode from the mobile station B, and to pass it on to the other mobile station C using the semiduplex mode (or vice versa). Direct coupling between the mobile stations B and C would be impossible since the mobile station B is located in an area (valley) which is shadowed from the mobile station C.

It is also possible to form a chain which includes a greater number of mobile stations.

The mobile stations have a control device which chooses between operation with one or two further stations or else operation as a repeater. If required, the control device may automatically select operation as a repeater. However, in order to avoid loading the power supply device in a mobile station in an uncontrolled manner, operation as a repeater can be inhibited.

The advantage of the mobile radio system in the present invention, in which mobile stations can be operated as repeaters, is, as described above, that even mobile stations which have no direct link to a base station due to shadowing can set up communication to other mobile stations and to the base station. A further advantage is that a mobile station likewise can be operated from an aircraft.In a conventional mobile radio system, operation of a mobile station from an aircraftwhile flying is normally impossible since the mobile station cannot set up communication with a specific base station from the large number of accessible base stations. By using mobile stations as repeaters which operate at a frequency suitable for them, however, it is possible to set up communication with one base station.

Furthermore, the mobile radio system in the present invention can be designed to be self organizing. By using new transmission methods such as JD-CMDA, it can provide very high transmission capacities. Such a combined system makes it possible to integrate virtually all the radio and mobile requirements which arise and operate with limited range and, possibly, with high traffic densities; such as wireless LAN, DSSR digital short range radio, LPD low power devices, TETRA trunked mobile radio and BOS, railroad radio, cordless telephones, mobile telephones, aviation radio, maritime radio, emergency paging systems and cordless buses (for control functions).

In one design variant of the present invention, the term duplex mode refers to a frequency division duplex (FDD) mode, and the term semiduplex mode refers to a time division duplex (TDD) mode. In this case, different frequency bands can be provided for the uplink (mobile station to base station) for FDD (Frequency Division Duplex) systems, such as the GSM system or UTRA (UMTS (Universal Mobile Telephony System) Terrestrial Radio Access) FDD mode than for the downlink (base station to mobile station), and different time periods can be provided for the uplink and downlink for TDD (Time Division Duplex) systems such as DECT (Digital Enhanced Cordless Telecommunications) system or the UTA (UMTS (Universal Mobile Telephony System) Terrestrial Radio Access) TDD mode.

Although the present invention has been described with reference to specific embodiments, those of skill in the art will recognize that changes may be made thereto without departing from the spirit and scope of the invention as set forth in the hereafter appended claims.

ABSTRACT OF THE DISCLOSURE

A mobile radio system containing a number of mobile stations, with the mobile stations having the ability to carry out transmission/reception operation in the duplex mode and in the semiduplex mode.

In the claims:

On page 8, cancel line 1, and substitute the following left-hand justified heading therefor:

I Claim as My Invention:

Please cancel claims 1-15, without prejudice and substitute the following claims therefor:

16. A mobile radio system, comprising:

at least one base station; and

a plurality of mobile stations including at a least first and a second mobile station, each of the plurality of mobile stations able to carry out transmission and reception operations in both a duplex mode and a semiduplex mode, the duplex mode being a frequency division duplex mode and the semiduplex mode being a time division duplex mode;

wherein the first mobile station simultaneously carries out transmission and reception operations with the at least one base station in the duplex mode and carries out transmission and reception operations with the second mobile station in the semiduplex mode.

17. A mobile radio system as claimed in claim 16, wherein the transmission and reception operations of the first mobile station are carried out cyclically in time slots, the time slots for the duplex and semiduplex modes running synchronously with respect to one another.

18. A mobile radio system as claimed in claim 16, wherein signals from the second mobile station are transmitted via the first mobile station to the base station, and signals from the base station are transmitted via the first mobile station to the second mobile station.

19. A mobile radio system as claimed in claim 17, wherein signals from the second mobile station are transmitted via the first mobile station to the base station, and signals from the base station are transmitted via the first mobile station to the second mobile station.

20. A mobile radio system as claimed in claim 16, wherein the first mobile station further carries out transmission and reception operations with a third mobile station in the semiduplex mode.

21. A mobile radio system as claimed in claim 17, wherein the first mobile station further carries out transmission and reception operations with a third mobile station in the semiduplex mode.

22. A mobile radio system as claimed in claim 18, wherein the first mobile station further carries out transmission and reception operations with a third mobile station in the semiduplex mode.

23. A mobile radio system as claimed in claim 19, wherein the first mobile station further carries out transmission and reception operations with a third mobile station in the semiduplex mode.

24. A mobile radio system as claimed in claim 16, wherein the first mobile station further carries out transmission and reception operations with a third mobile station in the semiduplex mode, such that signals from the second mobile station are transmitted via the first mobile station to the third mobile station, and signals from the third mobile station are transmitted via the first mobile station to the second mobile station.

25. A mobile radio system as claimed in claim 17, wherein the first mobile station further carries out transmission and reception operations with a third mobile station in the semiduplex mode, such that signals from the second mobile station are transmitted via the first mobile station to the third mobile station, and signals from the third mobile station are transmitted via the first mobile station to the second mobile station.

26. A mobile radio system as claimed in claim 18, wherein the first mobile station further carries out transmission and reception operations with a third mobile station in the semiduplex mode, such that signals from the second mobile station are transmitted via the first mobile station to the third mobile station, and signals from the third mobile station are transmitted via the first mobile station to the second mobile station.

27. A mobile radio system as claimed in claim 19, wherein the first mobile station further carries out transmission and reception operations with a third mobile station in the semiduplex mode, such that signals from the second mobile station are transmitted via the first mobile station to the third mobile station, and signals from the third mobile station are transmitted via the first mobile station to the second mobile station.

28. A mobile radio system as claimed in claim 24, wherein the plurality of mobile stations are coupled to one another to form at least one of a communication chain and a communication network.

29. A mobile radio system as claimed in claim 16, wherein the first mobile station may switch on and off, at least one of manually and automatically, the transmission of signals from the second mobile station via the first mobile station to the base station, and the transmission of signals from the base station via the first mobile station to the second mobile station.

30. A mobile radio system as claimed in claim 17, wherein the first mobile station may switch on and off, at least one of manually and automatically, the transmission of signals from the second mobile station via the first mobile station to the base station, and the transmission of signals from the base station via the first mobile station to the second mobile station.

31. A mobile radio system as claimed in claim 18, wherein the first mobile station may switch on and off, at least one of manually and automatically, the transmission of signals from the second mobile station via the first mobile station to the base station, and the transmission of signals from the base station via the first mobile station to the second mobile station.

32. A mobile radio system as claimed in claim 19, wherein the first mobile station may switch on and off, at least one of manually and automatically, the transmission of signals from the second mobile station via the first mobile station to the base station, and the transmission of signals from the base station via the first mobile station to the second mobile station.

33. A mobile radio system as claimed in claim 20, wherein the first mobile station may switch on and off, at least one of manually and automatically, the transmission of signals from the second mobile station via the first mobile station to at least one of the base station

and the third mobile station, and the transmission of signals from at least one of the base station and the third mobile station via the first mobile station to the second mobile station.

34. A mobile radio system as claimed in claim 21, wherein the first mobile station may switch on and off, at least one of manually and automatically, the transmission of signals from the second mobile station via the first mobile station to at least one of the base station and the third mobile station, and the transmission of signals from at least one of the base station and the third mobile station via the first mobile station to the second mobile station.

35. A mobile radio system as claimed in claim 22, wherein the first mobile station may switch on and off, at least one of manually and automatically, the transmission of signals from the second mobile station via the first mobile station to at least one of the base station and the third mobile station, and the transmission of signals from at least one of the base station and the third mobile station via the first mobile station to the second mobile station.

36. A mobile radio system as claimed in claim 23, wherein the first mobile station may switch on and off, at least one of manually and automatically, the transmission of signals from the second mobile station via the first mobile station to at least one of the base station and the third mobile station, and the transmission of signals from at least one of the base station and the third mobile station via the first mobile station to the second mobile station.

37. A mobile radio system as claimed in claim 24, wherein the first mobile station may switch on and off, at least one of manually and automatically, the transmission of signals from the second mobile station via the first mobile station to at least one of the base station and the third mobile station, and the transmission of signals from at least one of the base station and the third mobile station via the first mobile station to the second mobile station.

38. A mobile radio system as claimed in claim 25, wherein the first mobile station may switch on and off, at least one of manually and automatically, the transmission of signals from the second mobile station via the first mobile station to at least one of the base station and the third mobile station, and the transmission of signals from at least one of the base station and the third mobile station via the first mobile station to the second mobile station.

39. A mobile radio system as claimed in claim 26, wherein the first mobile station may switch on and off, at least one of manually and automatically, the transmission of signals from the second mobile station via the first mobile station to at least one of the base station and the third mobile station, and the transmission of signals from at least one of the base station and the third mobile station via the first mobile station to the second mobile station.

40. A mobile radio system as claimed in claim 27, wherein the first mobile station may switch on and off, at least one of manually and automatically, the transmission of signals from the second mobile station via the first mobile station to at least one of the base station and the third mobile station, and the transmission of signals from at least one of the base station and the third mobile station via the first mobile station to the second mobile station.

41. A mobile radio system as claimed in claim 28, wherein the first mobile station may switch on and off, at least one of manually and automatically, the transmission of signals from the second mobile station via the first mobile station to at least one of the base station and the third mobile station, and the transmission of signals from at least one of the base station and the third mobile station via the first mobile station to the second mobile station.

42. A mobile station in a mobile radio system, comprising a part for simultaneously carrying out transmission and reception operations with a base station in the mobile radio system in a duplex mode, and carrying out transmission and reception operations with a second mobile radio station in the mobile radio system in a semiduplex mode, wherein the duplex mode is a frequency division duplex mode and the semiduplex mode is a time division duplex mode.

43. A mobile station in a mobile radio system as claimed in claim 42, wherein the transmission and reception operations of the first mobile station are carried out cyclically in time slots, the time slots for the duplex and semiduplex modes running synchronously with respect to one another.

44. A mobile station in a mobile radio system as claimed in claim 42, wherein signals from the second mobile station are transmitted via the first mobile station to the base station, and signals from the base station are transmitted via the first mobile station to the second mobile station.

45. A mobile station in a mobile radio system as claimed in claim 43, wherein the first mobile station may switch on and off, at least one of manually and automatically, the transmission of signals from the second mobile station via the first mobile station to at least one of the base station and the third mobile station, and the transmission of signals from at least one of the base station and the third mobile station via the first mobile station to the second mobile station.

46. A mobile station in a mobile radio system as claimed in claim 42, further comprising a part for additionally carrying out transmission and reception operations with a third mobile station in the semiduplex mode.

47. A mobile station in a mobile radio system as claimed in claim 43, further comprising a part for additionally carrying out transmission and reception operations with a third mobile station in the semiduplex mode.

48. A mobile station in a mobile radio system as claimed in claim 44, further comprising a part for additionally carrying out transmission and reception operations with a third mobile station in the semiduplex mode.

49. A mobile station in a mobile radio system as claimed in claim 45, further comprising a part for additionally carrying out transmission and reception operations with a third mobile station in the semiduplex mode.

50. A mobile station in a mobile radio system as claimed in claim 42, further comprising a part for additionally carrying out transmission and reception operations with a third mobile station in the semiduplex mode, such that signals from the second mobile station

are transmitted via the first mobile station to the third mobile station, and signals from the third mobile station are transmitted via the first mobile station to the second mobile station.

51. A mobile station in a mobile radio system as claimed in claim 43, further comprising a part for additionally carrying out transmission and reception operations with a third mobile station in the semiduplex mode, such that signals from the second mobile station are transmitted via the first mobile station to the third mobile station, and signals from the third mobile station are transmitted via the first mobile station to the second mobile station.

52. A mobile station in a mobile radio system as claimed in claim 44, further comprising a part for additionally carrying out transmission and reception operations with a third mobile station in the semiduplex mode, such that signals from the second mobile station are transmitted via the first mobile station to the third mobile station, and signals from the third mobile station are transmitted via the first mobile station to the second mobile station.

53. A mobile station in a mobile radio system as claimed in claim 45, further comprising a part for additionally carrying out transmission and reception operations with a third mobile station in the semiduplex mode, such that signals from the second mobile station are transmitted via the first mobile station to the third mobile station, and signals from the third mobile station are transmitted via the first mobile station to the second mobile station.

54. A mobile station in a mobile radio system as claimed in claim 42, wherein the first mobile station may switch on and off, at least one of manually and automatically, the transmission of signals from the second mobile station via the first mobile station to the base station, and the transmission of signals from the base station via the first mobile station to the second mobile station.

55. A mobile station in a mobile radio system as claimed in claim 43, wherein the first mobile station may switch on and off, at least one of manually and automatically, the transmission of signals from the second mobile station via the first mobile station to the base station, and the transmission of signals from the base station via the first mobile station to the second mobile station.

56. A mobile station in a mobile radio system as claimed in claim 44, wherein the first mobile station may switch on and off, at least one of manually and automatically, the transmission of signals from the second mobile station via the first mobile station to the base station, and the transmission of signals from the base station via the first mobile station to the second mobile station.

57. A mobile station in a mobile radio system as claimed in claim 45, wherein the first mobile station may switch on and off, at least one of manually and automatically, the transmission of signals from the second mobile station via the first mobile station to the base station, and the transmission of signals from the base station via the first mobile station to the second mobile station.

58. A mobile station in a mobile radio system as claimed in claim 46, wherein the first mobile station may switch on and off, at least one of manually and automatically, the transmission of signals from the second mobile station via the first mobile station to at least one of the base station and the third mobile station, and the transmission of signals from at least one of the base station and the third mobile station via the first mobile station to the second mobile station.

59. A mobile station in a mobile radio system as claimed in claim 47, wherein the first mobile station may switch on and off, at least one of manually and automatically, the transmission of signals from the second mobile station via the first mobile station to at least one of the base station and the third mobile station, and the transmission of signals from at least one of the base station and the third mobile station via the first mobile station to the second mobile station.

60. A mobile station in a mobile radio system as claimed in claim 48, wherein the first mobile station may switch on and off, at least one of manually and automatically, the transmission of signals from the second mobile station via the first mobile station to at least one of the base station and the third mobile station, and the transmission of signals from at

least one of the base station and the third mobile station via the first mobile station to the second mobile station.

61. A mobile station in a mobile radio system as claimed in claim 49, wherein the first mobile station may switch on and off, at least one of manually and automatically, the transmission of signals from the second mobile station via the first mobile station to at least one of the base station and the third mobile station, and the transmission of signals from at least one of the base station and the third mobile station via the first mobile station to the second mobile station.

62. A mobile station in a mobile radio system as claimed in claim 50, wherein the first mobile station may switch on and off, at least one of manually and automatically, the transmission of signals from the second mobile station via the first mobile station to at least one of the base station and the third mobile station, and the transmission of signals from at least one of the base station and the third mobile station via the first mobile station to the second mobile station.

63. A mobile station in a mobile radio system as claimed in claim 51, wherein the first mobile station may switch on and off, at least one of manually and automatically, the transmission of signals from the second mobile station via the first mobile station to at least one of the base station and the third mobile station, and the transmission of signals from at least one of the base station and the third mobile station via the first mobile station to the second mobile station.

64. A mobile station in a mobile radio system as claimed in claim 52, wherein the first mobile station may switch on and off, at least one of manually and automatically, the transmission of signals from the second mobile station via the first mobile station to at least one of the base station and the third mobile station, and the transmission of signals from at least one of the base station and the third mobile station via the first mobile station to the second mobile station.

65. A mobile station in a mobile radio system as claimed in claim 53, wherein the first mobile station may switch on and off, at least one of manually and automatically, the transmission of signals from the second mobile station via the first mobile station to at least one of the base station and the third mobile station, and the transmission of signals from at least one of the base station and the third mobile station via the first mobile station to the second mobile station.

REMARKS

The present amendment makes editorial changes and corrects typographical errors in the specification, which includes the Abstract, in order to conform the specification to the requirements of United States Patent Practice. No new matter is added thereby. Attached hereto is a marked-up version of the changes made to the specification by the present amendment. The attached page is captioned "**Version With Markings To Show Changes Made".**

In addition, the present amendment cancels original claims 1-15 in favor of new claims 16-65. Claims 16-65 have been presented solely because the revisions by red-lining and underlining which would have been necessary in claims 1-15 in order to present those claims in accordance with preferred United States Patent Practice would have been too extensive, and thus would have been too burdensome. The present amendment is intended for clarification purposes only and not for substantial reasons related to patentability pursuant to 35 USC §§103, 102, 103 or 112. Indeed, the cancellation of claims 1-15 does not constitute an intent on the part of the Applicants to surrender any of the subject matter of claims 1-15.

Early consideration on the merits is respectfully requested.

Respectfully submitted,

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VERSIONS WITH MARKINGS TO SHOW CHANGES MADE

In The Specification:

The Specification of the present application, including the Abstract, has been amended as follows:

SPECIFICATION

TITLE

MOBILE RADIO SYSTEM, AND MOBILE STATION

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to a mobile radio system and to a mobile station which are suitable for carrying out transmission/reception operation in the duplex and semiduplex mode.

Description of the Prior Art

Previous mobile radio systems operating in the duplex mode operate at specific uplink and downlink frequencies, with each mobile station needing to have a direct link to a base station. In this case, signals between two mobile stations are not transmitted directly from one mobile station to the other, but via one or more base stations depending on the location of the mobile stations. If there is no link from the mobile stations to a base station, no link can be set up to another mobile station. Such a situation is shown in Figure 4. Although, as shown in Figure 4, the mobile station A can set up a link to the base station, the mobile station B cannot, since it is out of range of the base station (for example in a valley or on a bridge). No link, therefore, can ~~therefore~~ be set up between the mobile stations A and B even if, for example, there is a visual link between them. Since it has so far not been possible to overcome this disadvantage with mobile radio systems operating in the duplex mode, additional systems such as TETRA (Trans European Trunked Radio Access) have been developed and constructed, in which communication takes place directly between two mobile radios~~,~~ without using a base station. However, a mobile radio system operating in the duplex mode is advantageous for effective use of the available frequencies and base stations.

~~The~~ An object of the present invention is, thus, to provide a mobile radio system and a mobile station which, in addition to transmission/reception operation in the duplex mode, are also suitable for transmission/reception operation in the non-duplex mode.

~~The object is achieved by the features of the independent claims.~~

SUMMARY OF THE INVENTION

Accordingly, a mobile radio system having a number of mobile stations is provided, in which the mobile stations ~~have means for carrying~~ carry out transmission/reception operation in the duplex mode and in the semiduplex mode. The mobile stations are, thus, suitable for setting up communication to one or more mobile stations using the duplex and/or semiduplex mode.

According to one embodiment of the present invention, a first mobile station ~~contains means for carrying~~ carries out transmission/reception operation with a base station in the duplex mode, and with a second mobile station in the semiduplex mode~~, thus allowing~~ This allows simultaneous communication to be set up from the first mobile station in the duplex mode to the base station and to a second mobile station in the semiduplex mode, even when there is no link from the second mobile station to the base station.

Furthermore, ~~means are provided for carrying out~~ transmission/reception operation can be carried out with the base station in the duplex mode and with the second mobile station in the semiduplex mode, ~~in~~ such ~~a manner~~ that the transmission/reception operation is carried out cyclically in timeslots, and the timeslots for the duplex and semiduplex mode run synchronously with respect to one another. The timeslots for the duplex and semiduplex mode, thus can ~~thus~~ be superimposed (interleaved) in such a manner that the transmission/reception operation is carried out virtually simultaneously in the duplex and semiduplex mode without any mutual influence.

If the first mobile station ~~is provided with means for carrying~~ carries out transmission/reception operation with the base station in the duplex mode and with the second mobile station in the semiduplex mode, ~~in~~ such ~~a manner~~ that signals from the base station are transmitted via the first mobile station to the second mobile station and vice versa, communication can be set up between the base station and the second mobile station with the interposition of the first mobile station as a repeater~~,~~. This can be done even when there is no direct link from the second mobile stationto the base station.

In accordance with another embodiment of the present invention, the first mobile station ~~contains means for carrying~~ carries out transmission/reception operation with the second mobile station and with a third mobile station in the semiduplex mode~~, thus allowing~~ . This allows simultaneous communication to be set up directly from the first mobile station to the second and third mobile station in the semiduplex mode without any link to a base station.

If the first mobile station ~~is provided with means for carrying~~ carries out transmission/ reception operation with the second and the third mobile station in the semiduplex mode, ~~in~~ such ~~a manner~~ that signals from the second mobile station are transmitted via the one mobile station to the third mobile station and vice versa, communication can be set up between the second and third mobile station with the interposition of the one mobile station as a repeater even when there is no link between the second and third mobile station and any base station.

If a number of mobile stations are coupled to one another, then a communication chain or communication network of any desired size can be produced, in which case communication can be set up via a number of mobile stations with or without using base stations.

In order to avoid loading the power supply device of the first mobile station in an uncontrolled manner, the first mobile station ~~is equipped with means for~~ manually or automatically ~~switching~~ switches on and off the transmission of signals from the second mobile station via the first mobile station to the base station or to the third mobile station, and vice versa. The function of the first mobile station as a repeater, thus can ~~thus~~ be activated or deactivated.

Additional features and advantages of the present invention are described in, and will be apparent from, the Detailed Description of the Preferred Embodiments and the Drawings.

DESCRIPTION OF THE DRAWINGS

~~The present invention will be explained in the following description with reference to the drawing.~~

Figures 1 to 3 show various embodiments and operating modes of a mobile radio system according to the present invention;

Figure 4 shows a mobile radio system according to the prior art;

Figure 5 shows an illustration of frequency bands ~~to be~~ used in connection with the present invention; and

Figure 6 shows an illustration of timeslots ~~to be~~ used in connection with the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Conventional mobile radio systems, such as the GSM system, operate in the duplex mode and generally ~~using~~ use a timeslot method in which the transmitter and receiver are

active at different times. The transmitter in this case operates in the uplink frequency band, while the receiver operates in the downlink frequency band.

In the present invention, a semiduplex band is required as an additional band. As shown in Figure 5a, such a band may lie in another frequency band or, as shown in ~~figure~~ Figure 5b, may be arranged such that it is superimposed on the uplink and downlink frequencies.

Figure 6 shows a transmission/reception process within a transmission/reception cycle which is subdivided into eight timeslots (0 to 7). The semiduplex band (see Figure 6a) allows transmission and reception at the same frequency, with transmission and reception each being carried out in different timeslots. The reference symbol RXs in this case denotes reception, and TXs transmission of signals in the semiduplex band. The semiduplex band timeslots are synchronized to the duplex band timeslots (see Figure 6b) as in the GSM system, but they may differ both in the nature of the transmission~~,~~ and in length. The reference symbol RX denotes reception and TX denotes transmission of signals in the duplex band. Overall, ~~this means~~ makes that it is possible to work virtually simultaneously in both bands (see Figure 6c).

As shown in Figure 1, a mobile station A communicates with the base station using the duplex mode. In addition, the mobile station A can set up communication using the semiduplex mode with the mobile station B. There is no link between the mobile station B and the base station. It is, thus, possible for the mobile station A to communicate simultaneously with the base station and the mobile station B.

Figure 2 shows a situation in which the mobile station A is being used as a repeater. As in the situation shown in Figure 1, there is a direct link between the base station and the mobile station A, while there is no direct link between the base station and the mobile station B. However, the mobile station A converts the semiduplex mode information transmission to duplex mode information transmission, and vice versa, so that communication is set up between the base station and the mobile station B. ~~This means that~~ As such, data ~~are~~ is transmitted using the semiduplex mode from the mobile station B to the mobile station A, ~~are~~ processed in the mobile station A and ~~are~~ passed on using the duplex mode to the base station. ~~and, in~~ In the opposite direction, ~~are~~ the data is transmitted from the base station to the mobile station A using the duplex mode, ~~are~~ processed in the mobile station A, and ~~are~~ passed on to the mobile station B using the semiduplex mode.

As shown in Figure 3, it is likewise possible forthe mobile station A to communicate simultaneously with the mobile station B and the mobile station C using the semiduplex mode or, as a repeater, to receive information in the semiduplex mode from the mobile station B, and to pass it on to the other mobile station C using the semiduplex mode (or vice versa). Direct coupling between the mobile stations B and C would be impossible since the mobile station B is located in an area (valley) which is shadowed from the mobile station C.

It is also possible to form a chain ~~comprising~~ which includes a greater number of mobile stations.

The mobile stations have a control device which chooses between operation with one or two further stations or else operation as a repeater. If required, the control device may automatically select operation as a repeater. However, in order to avoid loading the power supply device in a mobile station in an uncontrolled manner, operation as a repeater can be inhibited.

The advantage of the mobile radio system in the present invention, in which mobile stations can be operated as repeaters, is, as described above, that even mobile stations which have no direct link to a base station due to shadowing can set up communication to other mobile stations and to the base station. A further advantage is that a mobile station ~~can~~ likewise can be operated from an aircraft.In a conventional mobile radio system, operation of a mobile station from an aircraftwhile flying is normally impossible since the mobile station cannot set up communication with a specific base station from the large number of accessible base stations. By using mobile stations as repeaters which operate at a frequency suitable for them, however, it is possible to set up communication with one base station.

Furthermore, the mobile radio system in the present invention can be designed to be self organizing. By using new transmission methods such as JD-CMDA, it can provide very high transmission capacities. Such a combined system makes it possible to integrate virtually all the radio and mobile requirements which arise and operate with limited range and, possibly, with high traffic densities~~:~~; such as wireless LAN, DSSR digital short range radio, LPD low power devices, TETRA trunked mobile radio and BOS, railroad radio, cordless telephones, mobile telephones, aviation radio, maritime radio, emergency paging systems and cordless buses (for control functions).

In one design variant of the present invention, the term duplex mode ~~means~~ refers to a frequency division duplex (FDD) mode, and the term semiduplex mode ~~means~~ refers to a

time division duplex (TDD) mode. In this case, different frequency bands can be provided for the uplink (mobile station to base station) for FDD (Frequency Division Duplex) systems, such as the GSM system or UTRA (UMTS (Universal Mobile Telephony System) Terrestrial Radio Access) FDD mode than for the downlink (base station to mobile station), and different time periods can be provided for the uplink and downlink for TDD (Time Division Duplex) systems such as DECT (Digital Enhanced Cordless Telecommunications) system or the UTA (UMTS (Universal Mobile Telephony System) Terrestrial Radio Access) TDD mode.

Although the present invention has been described with reference to specific embodiments, those of skill in the art will recognize that changes may be made thereto without departing from the spirit and scope of the invention as set forth in the hereafter appended claims.

ABSTRACT OF THE DISCLOSURE

A mobile radio system ~~contains~~ containing a number of mobile stations, with the mobile stations having ~~means for carrying~~ the ability to carry out transmission/reception operation in the duplex mode and in the semiduplex mode.

Patent Claims

1. A mobile radio system having a number of mobile stations (A, B, C),
with the mobile stations having means for carrying out transmission/reception operation in the duplex mode and in the semiduplex mode,
with a first mobile station (A) having means for simultaneously carrying out transmission/reception operation with a base station in the duplex mode and with a second mobile station (B) in the semiduplex mode, and
the duplex mode being in the form of the frequency division duplex mode, and the semiduplex mode being in the form of the time division duplex mode.

2. The mobile radio system as claimed in claim 1, characterized in that the first mobile station (A) has means for carrying out transmission/reception operation with the base station in the duplex mode and with the second mobile station (B) in the semiduplex mode in such a manner that the transmission/reception operation is carried out cyclically in timeslots, and the timeslots for the duplex and semiduplex mode run synchronously with respect to one another.

3. The mobile radio system as claimed in one of the preceding claims, characterized in that the first mobile station (A) has means for carrying out transmission/reception operation with the base station in the duplex mode and with the second mobile station (B) in the semiduplex mode, in such a manner that signals from the second mobile station are transmitted via the first mobile station to the base station, and vice versa.

4. The mobile radio system as claimed in one of the preceding claims, characterized in that the first mobile station (A) has means for carrying out transmission/reception

operation with the second mobile station (B) and with a third mobile station (C) in the semiduplex mode.

5. The mobile radio system as claimed in one of the preceding claims, characterized in that the first mobile station (A) has means for carrying out transmission/reception operation with the second (B) and the third (C) mobile station in the semiduplex mode, in such a manner that signals from the second mobile station are transmitted via the first mobile station to the third mobile station, and vice versa.

6. The mobile radio system as claimed in one of the preceding claims, characterized in that the mobile stations that are among the number of mobile stations are coupled to one another in such a manner that a communication chain or a communication network is formed.

7. The mobile radio system as claimed in one of the preceding claims, characterized in that the first mobile station (A) has means for manually or automatically switching on and off the transmission of signals from the second mobile station (B) via the first mobile station (A) to the base station or to the third mobile station (C), and vice versa.

8. A mobile station (A) having means for simultaneously carrying out transmission/reception operation with a base station in the duplex mode and with a second mobile station (B) in the semiduplex mode, with the duplex mode being in the form of the frequency division duplex mode, and the semiduplex mode being in the form of a time division duplex mode.

9. The mobile station (A) as claimed in claim 8, having means for carrying out transmission/reception operation with the base station in the duplex mode and with the second mobile station (B) in the semiduplex mode, in such a manner that the

transmission/reception operation is carried out cyclically in timeslots, and the timeslots for the duplex and semiduplex mode run synchronously with respect to one another.

10. The mobile station (A) as claimed in one of claims 8 to 9, having means for carrying out transmission/reception operation with the base station in the duplex mode and with the second mobile station (B) in the semiduplex mode, in such a manner that signals from the second mobile station are transmitted via the first mobile station to the base station, and vice versa.

11. The mobile station (A) as claimed in one of claims 8 to 10, having means for carrying out transmission/reception operation with the second mobile station (B) and with a third mobile station (C) in the semiduplex mode.

12. The mobile station (A) as claimed in one of claims 8 to 11, having means for carrying out transmission/reception operation with the second (B) and the third (C) mobile station in the semiduplex mode, in such a manner that signals from the second mobile station are transmitted via the first mobile station to the third mobile station, and vice versa.

13. The mobile station (A) as claimed in one of claims 8 to 12, having means for manually or automatically switching on and off the transmission of signals from the second mobile station (B) via the first mobile station (A) to the base station or to the third mobile station (C), and vice versa.

14. The mobile station (A) as claimed in one of claims 9 to 13, having means for carrying out transmission/reception operation with the second (B) and the third (C) mobile station in the semiduplex mode, in such a manner that signals from the second mobile station are transmitted via the first mobile station to the third mobile station, and vice versa.

15. The mobile station (A) as claimed in one of claims 9 to 14, having means for manually or automatically switching on and off the transmission of signals from the second mobile station (B) via the first mobile station (A) to the base station or to the third mobile station (C), and vice versa.

Description

Mobile radio system, and a mobile station

The present invention relates to a mobile radio system and to a mobile station which are suitable for carrying out transmission/reception operation in the duplex and semiduplex mode.

Previous mobile radio systems operating in the duplex mode operate at specific uplink and downlink frequencies, with each mobile station needing to have a direct link to a base station. In this case, signals between two mobile stations are not transmitted directly from one mobile station to the other, but via one or more base stations depending on the location of the mobile stations. If there is no link from the mobile stations to a base station, no link can be set up to another mobile station. Such a situation is shown in Figure 4. Although, as shown in Figure 4, the mobile station A can set up a link to the base station, the mobile station B cannot, since it is out of range of the base station (for example in a valley or on a bridge). No link can therefore be set up between the mobile stations A and B even if, for example, there is a visual link between them. Since it has so far not been possible to overcome this disadvantage with mobile radio systems operating in the duplex mode, additional systems such as TETRA (Trans European Trunked Radio Access) have been developed and constructed, in which communication takes place directly between two mobile radios, without using a base station. However, a mobile radio system operating in the duplex mode is advantageous for effective use of the available frequencies and base stations.

The object of the present invention is thus to provide a mobile radio system and a mobile station which, in addition

to transmission/reception operation in the duplex mode, are also suitable for transmission/reception operation in the non-duplex mode.

The object is achieved by the features of the independent claims.

Accordingly, a mobile radio system having a number of mobile stations is provided, in which the mobile stations have means for carrying out transmission/reception operation in the duplex mode and in the semiduplex mode. The mobile stations are thus suitable for setting up communication to one or more mobile stations using the duplex and/or semiduplex mode.

According to one embodiment of the present invention, a first mobile station contains means for carrying out transmission/reception operation with a base station in the duplex mode, and with a second mobile station in the semiduplex mode, thus allowing simultaneous communication to be set up from the first mobile station in the duplex mode to the base station and to a second mobile station in the semiduplex mode, even when there is no link from the second mobile station to the base station.

Furthermore, means are provided for carrying out transmission/reception operation with the base station in the duplex mode and with the second mobile station in the semiduplex mode, in such a manner that the transmission/reception operation is carried out cyclically in timeslots, and the timeslots for the duplex and semiduplex mode run synchronously with respect to one another. The timeslots for the duplex and semiduplex mode can thus be superimposed (interleaved) in such a manner that the transmission/reception operation is carried out virtually simultaneously in the duplex and semiduplex mode without any mutual influence.

If the first mobile station is provided with means for carrying out transmission/reception operation with the base station in the duplex mode and with the second mobile station in the semiduplex mode, in such a manner that signals from the base station are transmitted via the first mobile station to the second mobile station and vice versa, communication can be set up between the base station and the second mobile station with the interposition of the first mobile station as a repeater, even when there is no direct link from the second mobile station to the base station.

In accordance with another embodiment, the first mobile station contains means for carrying out transmission/reception operation with the second mobile station and with a third mobile station in the semiduplex mode, thus allowing simultaneous communication to be set up directly from the first mobile station to the second and third mobile station in the semiduplex mode without any link to a base station.

If the first mobile station is provided with means for carrying out transmission/reception operation with the second and the third mobile station in the semiduplex mode, in such a manner that signals from the second mobile station are transmitted via the one mobile station to the third mobile station and vice versa, communication can be set up between the second and third mobile station with the interposition of the one mobile station as a repeater even when there is no link between the second and third mobile station and any base station.

If a number of mobile stations are coupled to one another, then a communication chain or communication network of any desired size can be produced, in which case communication can be set up via a number of mobile stations with or without using base stations.

In order to avoid loading the power supply device of the first mobile station in an uncontrolled manner, the first mobile station is equipped with means for manually or automatically switching on and off the transmission of signals from the second mobile station via the first mobile station to the base station or to the third mobile station, and vice versa. The function of the first mobile station as a repeater can thus be activated or deactivated.

The present invention will be explained in the following description with reference to the drawing.

Figures 1 to 3 show various embodiments and operating modes of a mobile radio system according to the present invention;

Figure 4 shows a mobile radio system according to the prior art;

Figure 5 shows an illustration of frequency bands to be used; and

Figure 6 shows an illustration of timeslots to be used.

Conventional mobile radio systems, such as the GSM system, operate in the duplex mode and generally using a timeslot method in which the transmitter and receiver are active at different times. The transmitter in this case operates in the uplink frequency band, while the receiver operates in the downlink frequency band.

In the present invention, a semiduplex band is required as an additional band. As shown in Figure 5a, such a band may lie in another frequency band or, as shown in figure 5b, may be arranged such that it is superimposed on the uplink and downlink frequencies.

Figure 6 shows a transmission/reception process within a transmission/reception cycle which is subdivided into eight timeslots (0 to 7). The semiduplex band (see Figure 6a) allows transmission and reception at the same frequency, with transmission and reception each being carried out in different timeslots. The reference symbol RXs in this case denotes reception, and TXs transmission of signals in the semiduplex band. The semiduplex band timeslots are synchronized to the duplex band timeslots (see Figure 6b) as in the GSM system, but they may differ in the nature of the transmission, and in length. The reference symbol RX denotes reception and TX transmission of signals in the duplex band. Overall, this means that it is possible to work virtually simultaneously in both bands (see Figure 6c).

As shown in Figure 1, a mobile station A communicates with the base station using the duplex mode. In addition, the mobile station A can set up communication using the semiduplex mode with the mobile station B. There is no link between the mobile station B and the base station. It is thus possible for the mobile station A to communicate simultaneously with the base station and the mobile station B.

Figure 2 shows a situation in which the mobile station A is being used as a repeater. As in the situation shown in Figure 1, there is a direct link between the base station and the mobile station A, while there is no direct link between the base station and the mobile station B. However, the mobile station A converts the semiduplex mode information transmission to duplex mode information transmission, and vice versa, so that communication is set up between the base station and the mobile station B. This means that data are transmitted using the semiduplex mode from the mobile station B to the mobile station A, are processed in the mobile station A and are passed on using the duplex mode to the base station and, in the opposite

direction, are transmitted from the base station to the mobile station A using the duplex mode, are

processed in the mobile station A, and are passed on to the mobile station B using the semiduplex mode.

As shown in Figure 3, it is likewise possible for the mobile station A to communicate simultaneously with the mobile station B and the mobile station C using the semiduplex mode or, as a repeater, to receive information in the semiduplex mode from the mobile station B, and to pass it on to the other mobile station C using the semiduplex mode (or vice versa). Direct coupling between the mobile stations B and C would be impossible since the mobile station B is located in an area (valley) which is shadowed from the mobile station C.

It is also possible to form a chain comprising a greater number of mobile stations.

The mobile stations have a control device which chooses between operation with one or two further stations or else operation as a repeater. If required, the control device may automatically select operation as a repeater. However, in order to avoid loading the power supply device in a mobile station in an uncontrolled manner, operation as a repeater can be inhibited.

The advantage of the mobile radio system in the present invention, in which mobile stations can be operated as repeaters, is, as described above, that even mobile stations which have no direct link to a base station due to shadowing can set up communication to other mobile stations and to the base station. A further advantage is that a mobile station can likewise be operated from an aircraft. In a conventional mobile radio system, operation of a mobile station from an aircraft while flying is normally impossible since the mobile station cannot set up communication with a specific base station from the large number of accessible base stations. By using

mobile stations as repeaters which operate at a frequency suitable for them, however, it is possible to set up communication with one base station.

Furthermore, the mobile radio system in the present invention can be designed to be self-organizing. By using new transmission methods such as JD-CMDA, it can provide very high transmission capacities. Such a combined system makes it possible to integrate virtually all the radio and mobile requirements which arise and operate with limited range and, possibly, with high traffic densities: wireless LAN, DSSR digital short range radio, LPD low power devices, TETRA trunked mobile radio and BOS, railroad radio, cordless telephones, mobile telephones, aviation radio, maritime radio, emergency paging systems and cordless buses (for control functions).

In one design variant of the invention, the term duplex mode means a frequency division duplex (FDD) mode, and the term semiduplex mode means a time division duplex (TDD) mode. In this case, different frequency bands can be provided for the uplink (mobile station to base station) for FDD (Frequency Division Duplex) systems, such as the GSM system or UTRA (UMTS (Universial Mobile Telephony System) Terrestrial Radio Access) FDD mode than for the downlink (base station to mobile station), and different time periods can be provided for the uplink and downlink for TDD (Time Division Duplex) systems such as DECT (Digital Enhanced Cordless Telecommunications) system or the UTA (UMTS (Universial Mobile Telephony System) Terrestrial Radio Access) TDD mode.

Patent Claims

1. A mobile radio system having a number of mobile stations (A, B, C),
with the mobile stations having means for carrying out transmission/reception operation in the duplex mode and in the semiduplex mode.

2. The mobile radio system as claimed in claim 1, characterized in that a first mobile station (A) has means for carrying out transmission/reception operation with a base station in the duplex mode, and with a second mobile station (B) in the semiduplex mode.

3. The mobile radio station as claimed in one of the preceding claims, characterized in that the first mobile station (A) has means for carrying out transmission/reception operation with the base station in the duplex mode and with the second mobile station (B) in the semiduplex mode in such a manner that the transmission/reception operation is carried out cyclically in timeslots, and the timeslots for the duplex and semiduplex mode run synchronously with respect to one another.

4. The mobile radio system as claimed in one of the preceding claims, characterized in that the first mobile station (A) has means for carrying out transmission/reception operation with the base station in the duplex mode and with the second mobile station (B) in the semiduplex mode, in such a manner that signals from the second mobile station are transmitted via the first mobile station to the base station, and vice versa.

5. The mobile radio system as claimed in one of the preceding claims, characterized in that the first mobile station (A) has means for carrying out transmission/reception

operation with the second mobile station (B) and with a third mobile station (C) in the semiduplex mode.

6. The mobile radio system as claimed in one of the preceding claims, characterized in that the first mobile station (A) has means for carrying out transmission/reception operation with the second (B) and the third (C) mobile station in the semiduplex mode, in such a manner that signals from the second mobile station are transmitted via the first mobile station to the third mobile station, and vice versa.

7. The mobile radio system as claimed in one of the preceding claims, characterized in that the mobile stations that are among the number of mobile stations are coupled to one another in such a manner that a communication chain or a communication network is formed.

8. The mobile radio system as claimed in one of the preceding claims, characterized in that the first mobile station (A) has means for manually or automatically switching on and off the transmission of signals from the second mobile station (B) via the first mobile station (A) to the base station or to the third mobile station (C), and vice versa.

9. A mobile station (A) having means for carrying out transmission/reception operation in the duplex mode and in the semiduplex mode.

10. The mobile station (A) as claimed in claim 9, having means for carrying out transmission/reception operation with a base station in the duplex mode and with a second mobile station (B) in the semiduplex mode.

11. The mobile station (A) as claimed in one of claims 9 or 10, having means for carrying out transmission/reception operation with the base station in the duplex mode, and with the second

mobile station (B) in the semiduplex mode, in such a manner that the transmission/reception operation is carried out cyclically in timeslots, and the timeslots for the duplex and semiduplex mode run synchronously with respect to one another.

12. The mobile station (A) as claimed in one of claims 9 to 11, having means for carrying out transmission/reception operation with the base station in the duplex mode and with the second mobile station (B) in the semiduplex mode, in such a manner that signals from the second mobile station are transmitted via the first mobile station to the base station, and vice versa.

13. The mobile station (A) as claimed in one of claims 9 to 12, having means for carrying out transmission/reception operation with the second mobile station (B) and with a third mobile station (C) in the semiduplex mode.

14. The mobile station (A) as claimed in one of claims 9 to 13, having means for carrying out transmission/reception operation with the second (B) and the third (C) mobile station in the semiduplex mode in such a manner that signals from the second mobile station are transmitted via the first mobile station to the third mobile station, and vice versa.

15. The mobile station (A) as claimed in one of claims 9 to 14, having means for manually or automatically switching on and off the transmission of signals from the second mobile station (B) via the first mobile station (A) to the base station or to the third mobile station (C), and vice versa.

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Abstract

Mobile radio system, and a mobile station

A mobile radio system contains a number of mobile stations, with the mobile stations having means for carrying out transmission/reception operation in the duplex mode and in the semiduplex mode.